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(54) Title: POLISHING PADS AND METHODS RELATING THERETO

(57) Abstract

A polishing pad is provided which is comprised of vertically oriented fibers. Such pads can be produced by electrostatically flocking fibers onto a substrate. Preferably the fibers are hollow.

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POLISHING PADS AND METHODS RELATING THERETO

This application claims the benefit of U. S. Provisional Application No. 60/043405 filed on April 4, 1997.

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates to polishing pads used for creating a smooth, ultra-flat surface on such items as glass, semiconductors, dielectric/metal composites and integrated circuits.

Description of Related Art

Polishing generally consists of the controlled wear of an initially rough surface to produce a smooth specular finished surface. This is commonly accomplished by rubbing a pad against the surface of the article to be polished (the workpiece) in a repetitive, regular motion while a solution containing a suspension of fine particles (the slurry) is present at the interface between the polishing pad and the workpiece.

Polishing pads are normally produced by impregnation of felt with polymer solutions using water miscible solvents such as DMF followed by coagulation with water or water solvent blends, then drying and buffing or splitting/buffing. In another process the polymer solution is coated onto a substrate followed by coagulating. This process leads to the formation of vertically oriented pores (VO pores) which serve as slurry reservoir during

polishing. The impregnation/coagulating method gives material with mostly horizontally oriented fibers and the coating method results in a coating without any fiber reinforcement except the fibers present in the substrate. The only way to make polishing material with vertically oriented fibers is by laminating horizontally oriented product to make a vertically oriented product such as described in USPatent No. 4,728,552.

A patent which shows one method of forming a polishing sheet material with pores on the surface to provide slurry reservoir is USPatent No. 4,753,838. The pad surface is made of cellular polyurethane.

SUMMARY OF THE INVENTION

A polishing pad is provided which is comprised of vertically oriented fibers. Such pads can be produced by electrostatically flocking fibers onto a substrate. Preferably the fibers are hollow. Optionally, the pad comprised of vertically oriented fibers may be coated with a polymer solution to fill the voids between the fibers. The surface of pads coated with a polymer solution may be sanded to remove polymer skin and open the hollow fiber ends.

A method for polishing a workpiece is provided wherein polishing pads as described above are used to planarize a workpiece by contacting the surface of the polishing pad and a

surface of the workpiece while there is motion between the polishing pad and the workpiece.

DETAILED DESCRIPTION OF THE INVENTION

A process has been developed to make polishing pads containing vertically oriented fibers by electrostatically flocking fibers vertically onto substrates. The material may then be coated with polymer solution to fill the voids between the fibers. No polymer coating/impregnation may be needed if the fibers are flocked very densely. Of particular interest is a process variation which uses hollow or multichannel fibers such as hollow polyester or nylon fibers. This results in surface structures with increased slurry reservoir. Hollow polyester and nylon fibers are commercially available as well as higher denier triocular and tetraocular nylon (Tynex, a trademark of the DuPont Company). Hollow fiber felts made by electrostatic flocking and used for the impregnation/coagulating process give polishing surfaces with vertically oriented hollow fibers which act as slurry reservoir by themselves or in combination with the pores generated during coagulation. This process results in a new type of polishing pad which not only has vertically oriented fiber reinforcement but also has increased slurry uptake because of the hollow nature of the fiber used.

A variety of samples were prepared by flocking solid and one- or multichannel fibers electrostatically onto substrates with most of the fibers vertically oriented. Microscope examination of flocked fiber samples show nearly 100% vertical fiber orientation. The fiber flock used was usually between 0.4 to 0.8 mm in length. Hollow fibers used in the experiments included hollow polyester and 3- and 4- channel nylon. Some samples were coated with polyurethane solutions to fill the voids between the fibers. The coagulated material was sanded to remove the skin and to open the hollow fiber ends and pores in the polymer.

Fibers flocked onto a polymer film or onto a foamed backing (such as foamed rubber) provided surfaces which would make excellent pads for chemical mechanical planarization. The surface was very uniform and choice of backing material makes it possible to obtain the desired stiffness or resilience for a given polishing operation.

Electrostatic flocking of short, high denier fibers is a well known art. Any type of adhesive may be used to adhere the vertically oriented fibers to a substrate. The adhesive may be a hot melt, aqueous based, or solvent based. For the purpose of making the surface layer of a pad useful for chemical mechanical polishing of a workpiece, such as a semiconductor wafer, the adhesive needs to be resistant to water and alkaline conditions up to a pH of 12. Since polyurethanes are commonly used in the manufacture of pads

for chemical mechanical polishing, they are a preferred material for the flocking process adhesive.

The scope of the invention is limited only by the claims which follow.

CLAIMS

1. A polishing pad comprised of vertically oriented fibers said pad being produced by electrostatically flocking fibers onto a substrate.
2. A polishing pad according to claim 1 wherein said fibers are hollow.
3. A polishing pad according to claim 1 wherein said pad comprised of said fibers electrostatically flocked onto said substrate is coated with a polymer solution to fill the voids between said fibers.
4. A polishing pad according to claim 2 wherein said pad comprised of said fibers electrostatically flocked onto said substrate is coated with a polymer solution to fill the voids between said fibers.
5. A polishing pad according to claim 4 wherein the surface of said coated pad is sanded to remove polymer skin and open the hollow fiber ends.
6. A polishing pad according to claim 4 wherein said polymer solution is a urethane polymer solution.
7. A polishing pad according to claim 2 wherein said fibers are polyester or nylon.
8. A polishing pad according to claim 1 wherein said fibers are between about 0.4 and 0.8 mm in length.

9. A polishing pad according to claim 2 wherein said fibers are between about 0.4 and 0.8 mm in length.

10. A method for polishing a workpiece comprising: (a) providing a polishing pad comprised of vertically oriented fibers said pad being produced by electrostatically flocking fibers onto a substrate, (b) planarizing said workpiece by contacting the surface of said polishing pad and said workpiece while there is motion between said polishing pad and said workpiece.

11. A method according to claim 10 wherein said fibers are hollow.

12. A method according to claim 10 wherein said pad comprised of said fibers electrostatically flocked onto said substrate is coated with a polymer solution to fill the voids between said fibers.

13. A method according to claim 11 wherein said pad comprised of said fibers electrostatically flocked onto said substrate is coated with a polymer solution to fill the voids between said fibers.

14. A method according to claim 13 wherein the surface of said coated pad is sanded to remove polymer skin and open the hollow fiber ends.

15. A method according to claim 13 wherein said polymer solution is a urethane polymer solution.

16. A method according to claim 11 wherein said fibers are polyester or nylon.

17. A method according to claim 10 wherein said fibers are between about 0.4 and 0.8 mm in length.

18. A method according to claim 10 wherein said fibers are between about 0.4 and 0.8 mm in length.

INTERNATIONAL SEARCH REPORT

[redacted]national application No.
[redacted]/US98/06757

A. CLASSIFICATION OF SUBJECT MATTER

IPC(6) :B32B 3/02; A47K 7/02

US CL :428/90; 15/209.1

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 428/90; 15/209.1

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X -- Y	US 3,772,132 A (DULIN, JR.) 13 November 1973, see entire document.	1, 3, 8 --- 2, 4-7, 9-18
Y	US 5,569,521 A (FRANCOEUR, SR. et al.) 29 October 1996, see entire document.	1-18

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

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